CEMENT AND LIME MANUFACTURE

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The Hardening of Portland Cement.

IN the year 1937 Mr. Rune Hedin started an investigation of the hardening of Portland cement at the laboratory of the Skanska Cementaktiebolaget at Linnhamm, Sweden, and the work was completed at the Department of Chemical Technology of the Kungl. Tekniska Hogskolan in Stockholm. The results of the investigation have now been published in the English language with the assistance of the British Council, and published under the title "Chemical Processes in the Hardening of Portland Cement" (152 pages) by the Kungl. Tekniska Hogskolan.

The investigations were intended to throw light on the chemical reactions that take place when a mixture of Portland cement and water hardens under normal conditions, and the author states that from the experimental results obtained it is possible to draw the following conclusions.

All the clinker minerals are first dissolved in the water while retaining their stoicheiometric compositions. The crystallised minerals have in this connection a rather lower rate of solubility than the minerals in the form of hardened glass. The solution formed contains chiefly calcium-ions, silicate-ions and aluminate-ions. Owing to hydrolysis there are present also free silicic acid and aluminium-hydroxide in the solution. By dissolution of added substances mixed with the cement, e.g. gypsum, the ion concentrations and ion activities in the solution can be changed.

With a sufficiently high aluminate-ion concentration the free silicic acid is coagulated. At the same time the aluminium-hydroxide is precipitated by the silicate-ions. Due to coagulation the concentration of the calcium-silicate in the solution is kept very low, and the dissolution is therefore extremely rapid. As the dissolution of the tri-calcium-silicate is a strongly exothermic reaction, the cement mass develops considerable heat. The gel-products, formed quickly, enclose the cement grains, so that they are prevented from coming into contact with the water. The reaction thus stops after a relatively short time.

If the calcium-ion concentration in the solution, on account of the composition of the cement clinker, or by additions, is kept high in relation to the existing amount of aluminates, the concentration or activity of the aluminate-ions will be so far reduced that the coagulation-reaction does not take place. The silicates and aluminates present in the solution will then be hydrated to form compounds whose solubility is less than the solubility of the original anhydrous materials. The fluid phase will thus be super-saturated the whole time relative to these products of hydration that crystallise ; but it will be unsaturated relative to the anhydrous material. Consequently, the reaction proceeds until either the water has been consumed or all the anhydride material has been converted.

The composition of the hydrated products is completely dependent on the concentration conditions obtaining in the solution.

The aluminates give rise to tri-calcium-aluminate-hydrate or tetra-calcium-aluminate-hydrate ; or, if gypsum is present, to tri-calcium-aluminate-mono-sulphate-hydrate.

The silicates are hydrated to calcium-silicate-hydrate, with a molecular ratio of $CaO : SiO_2$ which in saturated lime-solution is 3 : 2 ; but in the case of strong super-saturation of the solution with lime it may rise to 2 : 1. As the silicate-containing anhydrous material consists chiefly of tri-calcium-silicate, the lime-content of the solution will rise rapidly to strong supersaturation and calcium-hydroxide will crystallise. It should be noted in this connection that it has been possible to show that the main component of Portland cement, alite, has a very much higher rate of solubility than has pure tri-calcium-silicate.

The ferrites have a very low rate of solubility, and they therefore exercise scarcely any influence on the reaction in other respects before the cement mass has already begun to harden to a notable extent. They are, however, gradually converted to ferric-hydroxide, which on account of its structure envelopes the cement grains like a protective film and retards the dissolution. If the concentration of lime and gypsum in the solution is high, however, the rate of solubility of the iron components is near to zero, and they then have no noticeable effect on the other reactions. Moreover, the ferric-hydroxide that may in this case have been formed is converted to the crystallised compounds tetra-calcium-ferri-hydrate or tri-calcium-ferri-mono-sulphate-hydrate.

The alkalis in the Portland cement, which for the most part occur in the form of alkali-containing aluminates, have an extremely high rate of solubility, and they give rise to strongly alkali-containing solutions in which no high calcium-ion concentration can be attained. The silicic acid is thus coagulated even if free lime is present in excess. If there is excess of gypsum, however, a sufficiently high calcium-ion concentration can be attained in the solution, and the coagulation reaction does not take place.

If a big excess of an easily-soluble calcium salt such as $CaCl_2$ is added to a Portland cement, the pH-value of the lime-solution formed is reduced to about 11. The aluminate-hydrates are more easily soluble in such a solution than the

aluminium-hydroxide. The latter then crystallises and binds the grains in the cement mass together, in which connection so-called false setting results.

In the presence of borax, humus, sugar, and other substances that give rise to calcium salts with a low degree of dissociation, or insoluble calcium compounds, the calcium-ion concentration in the solution cannot attain a sufficiently high value and the consequence is a pronounced coagulation of silicic acid.

A Spanish Cement Factory.

THE following description of the "Cementos Rezola" cement works at Anorga, San Sebastian, which was completely rebuilt between the two wars, is abstracted from an article by Sr. Julian Rezola in a recent number of the Spanish journal "Cemento." The output is 180,000 tons a year, and the dry process is used. The raw materials are limestone and marl.

Fig. 1.—The Rezola Cement Works, Spain.

Raw Materials.

In order to correct any differences in the composition of the marl there is a series of eleven hoppers, each of 150 tons capacity, before the second crushing process, and 7 other hoppers of 300 tons capacity each after the dryers, all fitted with adjustable discharge so that an even mixture is obtained by taking a portion from each hopper. The limestone is practically pure (98 per cent. CaO). and any differences are corrected at the mills. A Fuller pump transport system, with a device that periodically (every two minutes) changes the silo into which the raw material is deposited, results in a very uniform mixture. *Fig.* 1 shows the plant.

The storage department is 320 ft. long by 63 ft. wide, and is capable of holding 5,000 tons of raw material, 10,000 tons of clinker, 1 ton of gypsum, and 3,000 tons

of artificial pozzolana. The limestone is excavated by boring, using drills driven by a 50-h.p. Ingersoll-Rand compressor. A crawler-mounted Ruston excavator, with a grab capacity of 1½ cubic yards, loads the stone into 6-ton trucks with tipping platforms, which take it by rail to a Titan crusher in the quarry. The crusher has a capacity of 100 tons per hour, and has a screen with 1-in. meshes. The crusher is driven by two non-synchronous, 150-h.p., 3,000-volt motors. The crushed stone falls into a hopper, from which it is taken in trucks to the store in the factory. The same method is used for excavating both the limestone and the marl. A crusher of smaller dimensions and with a capacity of 30 tons per hour, and two stone-breakers capable of crushing 20 tons per hour, are also installed. The second grinding takes place in a Symons conical mill having a capacity of 40 tons per hour; this reduces the size of the stone to a maximum of ½ in.

Both the marl and the limestone are compact in texture and free from any trace of moisture but, since they are moistened by rain, drying is necessary. This is done in two Ruggles-Coles dryers with a capacity of 60 tons per hour. The gases of combustion are extracted mechanically. In order to prevent condensation of the water vapour carried with the gases, the chambers are lined with hollow concrete blocks, and in order to prevent condensation when the external temperature is very low a device is used for introducing warm air into the chambers. A gantry crane takes the dried material to the final grinding mill, and the resulting powder is carried by worm conveyor to the Fuller pump, which feeds it into eight raw material silos; the pump has a capacity of 40 tons per hour.

Compound mills are used for grinding both the raw material and the clinker. It is realised that these may be more costly in power requirements than other types, but this is not important in view of the fact that power for the works is obtained from waterfalls. There are also two 36 ft. by 7 ft. 3 in. Unidan mills driven by 500 kw. motors, and two further 36 ft. by 6 ft. mills of the Compound type driven by 260 kw. motors. The Unidan and Compound mills yield 18 tons of raw material per hour with 6 per cent. fineness and a consumption of 400 kw.; the same mills produce 14 tons of cement with 4 to 5 per cent. fineness and a consumption of 410 kw.

The Kilns.

Vertical kilns were used before the works was reconstructed, and a Lepol kiln was installed in the new works. The results obtained were so satisfactory that another Lepol kiln was installed in 1942. These two kilns have capacities of 250 tons and 300 tons per day respectively, and there are also three Andreas kilns with a total capacity of 300 tons per day. The higher rate of production of the second Lepol kiln is due to the fact that it has a greater contact surface than the first. The fuel consumption of the Lepol kilns, with fine coal of 7,000 to 7,500 calories, is 90,000 to 95,000 calories per ton of clinker and, owing to the high temperature of the secondary air entering the kiln and of the flame, semi-dry coal may be used. In this type of kiln, when the exit temperature of the gas is low, small granules are ejected through the chimney, especially when the silica content of the raw material is high. It would appear that the soot formed by

the gases on cooling is responsible for the dust collecting in the form of granules ; the emission of these granules does not, however, appear to be more objectionable than the dust emitted by some rotary kilns. A device for collecting the granules and dust has now been installed.

The coal store has a capacity of 12,000 tons of three different types of coal, which is handled by a bucket-grab suspended from a mono-rail. After mixing, the coal is taken on belt conveyors to the coal dryer, the kilns, or to the " Resolutors." The coal grinding plant is a Polysius machine, 4 ft. by 23 ft., with three compartments and a capacity of 3 tons per hour. The first Lepol kiln is fitted with a Resolutor having a capacity of 2½ to 3 tons per hour, and a similar one is to be installed in the second kiln, first passing the coal through the dryer if necessary.

Storage and Packing.

The cement is taken by conveyors and hoists to seven silos, each with a capacity of 300 tons, from which it is extracted by double-worm dischargers, two in each silo, and taken to three storage silos with internal diameters of 30 ft., useful heights of 82 ft. 6 in., and capacities of 2,000 tons ; one is used for " marine " cement and the other two for Portland cement. Each silo is provided with four double-worm dischargers. Two bag-filling machines are used, each with three valves and a capacity of 600 to 800 bags per hour. For the storage of high-strength cement there are nine silos of 65 tons each. The " marine " cement is a mixture of Portland cement and artificial pozzolana.

Soundness Test for Hydrated Limes.

AN investigation has been undertaken by the United States National Bureau of Standards to develop an accelerated autoclave test for the purpose of differentiating hydrated limes which can cause a marked expansion, with resulting failure in the finish coat of plaster, from those giving little or no expansion. With the test procedure that has been developed, 57 different limes have been mixed with one brand of Portland cement, cast into bars, and the expansion of the bars after autoclaving has been determined. In addition, 32 of the limes have been tested, in part with 18 other cements. A total of 148 determinations has been made.

It has been found that all of the " regular dolomitic hydrated limes " that have been causing trouble, regardless of the cements used, gave expansions ranging from 4·7 to 16·4 per cent. When these dolomitic hydrated limes are properly hydrated and the free MgO reduced to 5 per cent. or less, net expansions were (with two exceptions) less than 0·5 per cent. after deduction of the expansion of the cement used. The exceptions applied to those cements which gave the larger expansions when tested without the addition of the lime. Every high-calcium hydrated lime, regardless of the cement used, gave expansions less than 0·5 per cent. Thus it would appear that, when the proper cement is used, a satisfactory autoclave test has been developed for determining the soundness of hydrated limes.

The Nephelometric Determination of Sulphuric Anhydride in Cements.*

By LÉON BLONDIAU.

(DIRECTOR OF THE S. A. DES CIMENTS DE THIEU.)

Application to Hypersulphated Metallurgical Cements: Results.

The accuracy of the nephelometric method entails the need of keeping the heights of suspension between 40 mm. and 100 mm.; for this reason the method was modified according to the SO_3 content and the hypersulphated cements divided into two classes. The first class, comprising normal hypersulphated metallurgical cements, included cements containing from 3 per cent. to 7 per cent. SO_3, regarding contents lower than 5 per cent. and higher than 6 per cent. as accidental. The second class, comprising hypersulphated metallurgical high-resistance cements, included cements containing from 6 per cent. to 14 per cent. SO_3, regarding contents lower than 6 per cent. and higher than 10 per cent. as accidental. Each type of cement was subjected to two series of tests similar to those carried out on Portland and blastfurnace cements.

TABLE XVII.

RESULTS OF 1st SERIES OF TESTS ON NORMAL HYPERSULPHATED METALLURGICAL CEMENT												
	3·35% SO_3				5·56% SO_3				7·48% SO_3			
	SO_3 according to Belgian gravimetric method	SO_3 according to nephelometric method operator			SO_3 according to Belgian gravimetric method	SO_3 according to nephelometric method operator			SO_3 according to Belgian gravimetric method	SO_3 according to nephelometric method operator		
		A	B	C		A	B	C		A	B	C
AVERAGE	3·35	3·36	3·43	3·42	5·56	5·58	5·49	5·59	7·42	7·41	7·38	7·33
AVERAGE DEVIATIONS	0·020	0·015	0·028	0·031	0·040	0·026	0·051	0·049	0·044	0·048	0·045	0·077
MAXIMUM DEVIATIONS	0·08	0·04	0·08	0·08	0·17	0·12	0·16	0·24	0·15	0·20	0·10	0·20
QUADRATIC DEVIATIONS	0·024	0·017	0·031	0·032	0·054	0·028	0·060	0·062	0·050	0·064	0·050	0·086
RELATIVE AVERAGE D	0·60%	0·44%	0·81%	0·90%	0·72%	0·46%	0·93%	0·87%	0·59%	0·65%	0·61%	1·05%

(1) Normal hypersulphated metallurgical cements.—In the first series of tests, the average results of which are given in *Table XVII*, the conclusions drawn from tests on Portland cements are confirmed. In this case, however, the average deviations between the results of the two methods reach a maximum of 0·09 per cent. with a relative deviation of 1·21 per cent. from the gravimetric result. Nevertheless, for an accidental amount of 3·35 per cent. SO_3, the relative deviation amounted to 2·39 per cent. of the gravimetric result. As is indicated by the method of calculating the SO_3 content of hypersulphated metallurgical cements, the deviations of the nephelometric method, low though they are, nevertheless exceed the deviations of the gravimetric method. Relative deviations, however, remain low and in no way condemn the application of this method

* Concluded from September and November, 1945.

to cements of this SO_3 content. Deviations between different operators were confined to a maximum of 0·10 per cent., viz., 1·79 per cent. of the gravimetric method.

The results of the second series of tests, of which ten are reproduced in *Table XVIII*, confirm the regularity and accuracy of the method. The maximum values attained by the absolute maximum and average deviations between the two methods are respectively 0·19 per cent. and 0·13 per cent. The relative

TABLE XVIII.

EXTRACT OF RESULTS OF 2ND SERIES OF TESTS ON NORMAL HYPERSULPHATED METALLURGICAL CEMENT

No OF SAMPLES	BELGIAN GRAVIMETRIC METHOD				NEPHELOMETRIC METHOD				COMPARISON OF 2 METHODS		
	AVERAGE RESULTS	MAXIMUM DEVIATIONS	ABSOLUTE AVERAGE DEVIATIONS	RELATIVE AVERAGE DEVIATIONS	AVERAGE RESULTS	MAXIMUM DEVIATIONS	ABSOLUTE AVERAGE DEVIATIONS	RELATIVE AVERAGE DEVIATIONS	MAXIMUM DEVIATIONS	ABSOLUTE AVERAGE DEVIATIONS	RELATIVE AVERAGE DEVIATIONS
5	4·50	0·01	0·00	0·00	4·38	0·00	0·00	0·00	0·13	0·12	2·75
10	4·99	0·17	0·06	1·20	5·12	0·14	0·05	0·97	0·27	0·13	2·61
15	5·23	0·03	0·01	0·19	5·18	0·04	0·01	0·19	0·09	0·05	0·95
20	5·30	0·10	0·03	0·56	5·25	0·04	0·02	0·38	0·11	0·05	0·94
25	5·46	0·11	0·04	0·73	5·44	0·00	0·00	0·00	0·06	0·02	0·36
30	5·51	0·05	0·02	0·36	5·51	0·10	0·04	0·71	0·09	0·00	0·00
35	5·60	0·08	0·03	0·53	5·55	0·05	0·02	0·36	0·13	0·05	0·89
40	5·82	0·02	0·01	0·17	5·91	0·10	0·04	0·68	0·13	0·09	1·54
45	6·79	0·10	0·03	0·44	6·75	0·06	0·02	0·29	0·12	0·04	0·59
50	7·59	0·06	0·02	0·26	7·60	0·00	0·00	0·00	0·04	0·01	0·13

TABLE XIX.

RESULTS OF 1ST. SERIES OF TESTS ON HYPERSULPHATED METALLURGICAL HIGH RESISTANCE CEMENT

	5·56% SO_3				7·42% SO_3				11·22% SO_3			
	SO_3 ACCORDING TO BELGIAN GRAVIMETRIC METHOD	SO_3 ACCORDING TO NEPHELOMETRIC METHOD OPERATOR			SO_3 ACCORDING TO BELGIAN GRAVIMETRIC METHOD	SO_3 ACCORDING TO NEPHELOMETRIC METHOD OPERATOR			SO_3 ACCORDING TO BELGIAN GRAVIMETRIC METHOD	SO_3 ACCORDING TO NEPHELOMETRIC METHOD OPERATOR		
		A	B	C		A	B	C		A	B	C
AVERAGE	5·56	5·55	5·63	5·57	7·42	7·38	7·35	7·37	11·22	11·22	11·24	11·18
AVERAGE DEVIATIONS	0·040	0·028	0·019	0·070	0·044	0·083	0·079	0·059	0·052	0·102	0·072	0·060
MAXIMUM DEVIATIONS	0·17	0·12	0·06	0·20	0·15	0·26	0·26	0·24	0·20	0·24	0·24	0·12
QUADRATIC DEVIATIONS	0·054	0·035	0·021	0·077	0·050	0·092	0·091	0·074	0·058	0·109	0·089	0·060
RELATIVE AVERAGE D.	0·72%	0·50%	0·34%	1·25%	0·59%	1·19%	1·07%	0·80%	0·46%	0·96%	0·64%	0·55%

average deviation attains a maximum of 2·75 per cent. of the gravimetric method, i.e. a smaller amount than in the case of Portland cements.

(2) *Hypersulphated metallurgical high-resistance cements.*—Working on one-fourth of the normal sample results in greater deviations, at least in so far as maximum deviations are concerned, but the amounts are not great and do not impair the success of the method. The results shown in *Table XIX* establish

agreement between the gravimetric and the nephelometric results. The average deviations between the two methods are confined to a maximum of 0·07 per cent. and the relative average deviations to 1·26 per cent. of the gravimetric result.

The results of the second series of tests confirmed the findings of the first series. In this series (*Table XX*) deviations between the two methods were : Maximum, 0·30 per cent. ; absolute average, 0·22 per cent. ; relative average, 2·82 per cent.

The tests on both classes of hypersulphated metallurgical cements establish that from the point of view of accuracy and regularity the method may be adopted for checking the manufacture of these cements. In this instance the speed of execution, owing to the taking of aliquot parts and the addition of acid, is somewhat slower (15 to 17 minutes) according to whether the tests are made singly or as part of a series. This time may be reduced if care is taken to effect filtration in a vessel cooled by cold water.

TABLE XX.

EXTRACT OF RESULTS OF 2ND. SERIES OF EXPERIMENTS ON HYPERSULPHATED METALLURGICAL HIGH RESISTANCE CEMENT

No. OF SAMPLES	BELGIAN GRAVIMETRIC METHOD				NEPHELOMETRIC METHOD				COMPARISON OF 2 METHODS		
	AVERAGE RESULTS	MAXIMUM DEVIATION	ABSOLUTE AVERAGE DEVIATIONS	RELATIVE AVERAGE DEVIATIONS	AVERAGE RESULTS	MAXIMUM DEVIATIONS	ABSOLUTE AVERAGE DEVIATIONS	RELATIVE AVERAGE DEVIATIONS	MAXIMUM DEVIATIONS	ABSOLUTE AVERAGE DEVIATIONS	RELATIVE AVERAGE DEVIATIONS
5	6·28	0·08	0·03	0·47	6·24	0·08	0·03	0·48	0·13	0·04	0·63
10	6·55	0·02	0·01	0·15	6·43	0·08	0·04	0·62	0·16	0·12	1·83
15	6·79	0·10	0·03	0·44	6·72	0·00	0·00	0·00	0·12	0·07	1·03
20	6·92	0·03	0·01	0·14	6·86	0·00	0·00	0·00	0·08	0·06	0·86
25	7·10	0·08	0·03	0·42	7·09	0·08	0·03	0·42	0·11	0·01	0·14
30	7·19	0·10	0·03	0·42	7·18	0·05	0·02	0·28	0·10	0·01	0·14
35	7·41	0·03	0·01	0·13	7·40	0·14	0·07	0·95	0·09	0·01	0·13
40	7·69	0·03	0·01	0·13	7·61	0·15	0·05	0·65	0·16	0·08	1·04
45	10·68	0·08	0·03	0·28	10·88	0·00	0·00	0·00	0·25	0·20	1·87
50	12·98	0·07	0·03	0·23	13·20	0·00	0·00	0·00	0·25	0·22	1·69

Conclusions.

From practical tests which, together with preliminary tests, have required over 3,000 determinations of sulphuric anhydride, it is concluded that if the recommended practice is followed the nephelometric method is suitable for checking the manufacture of the various cements and possesses the advantages of accuracy, regularity, simplicity, and speed. The determinations dealt with in this study were in accordance with a method that has been perfected in the laboratories of the S.A. des Ciments de Thieu by using a nephelometer constructed according to Belgian patent No. 448,926 filed in the names of the S.A. des Ciments de Thieu and the writer.

A Mobile Laboratory for Testing Concrete.

THE following description of a mobile laboratory for testing concrete has been issued by the Road Research Laboratory of the Department of Scientific and Industrial Research. The Road Research Laboratory inform us that they will be pleased to supply further information on request, or arrange for the Laboratory's unit to be inspected. In addition to the concrete-testing unit the Laboratory has mobile units for testing soils and for carrying out analyses of bituminous materials. Particulars of these will also be supplied on request.

The laboratory is mounted on a 6-ton four-wheel trailer chassis. The body is 17 ft. long by 7 ft. 6 in. wide and has an internal height of 6 ft. 6 in. The

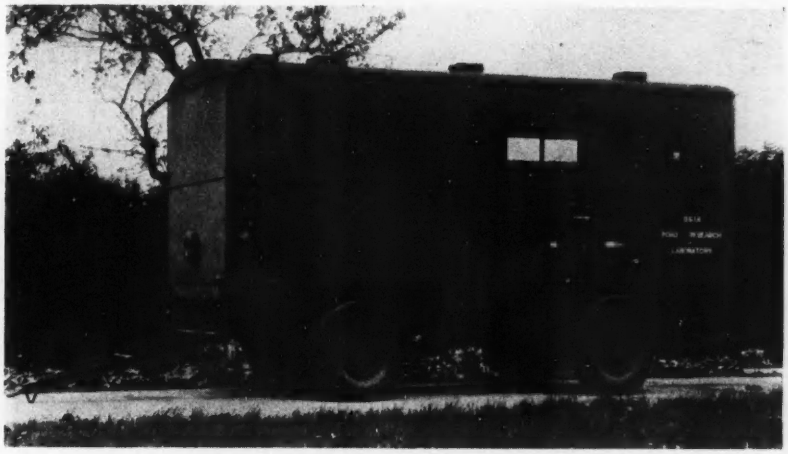


Fig. 1.—Mobile Testing Laboratory.

general arrangement is shown in *Fig.* 3, and other details are shown in *Figs.* 1 and 2. The trailer was specially built to designs prepared by the Laboratory and is equipped for (1) standard cement tests; (2) examination and testing of aggregates; (3) tests for controlling concrete quality, such as the measurement of moisture in aggregates and slump tests; (4) making concrete cubes and testing for compressive strength; and (5) general experimental work on concrete and other constructional materials. Except on unusually steep gradients the trailer can be hauled by a 4-5-ton lorry.

Heating is by means of butane (Calor gas) stored in liquid form in cylinders, each containing enough for about two weeks' normal use. Space is provided for two spare cylinders. Gas taps of the usual laboratory type are fitted at various points in the benches.

Electricity is obtained from a 1·5 K.V.A. 240-volt, single-phase petrol-driven alternator. The alternator can be operated in its normal position under the bench, but provision is made for sliding it out on to a trestle outside the laboratory so that it can be run without causing vibration. The alternator supplies electricity for lighting and for various items of apparatus, such as the sieve-shaker and the mortar-cube vibrator. When electricity is available from mains a connection can be made by means of a cable carried in the laboratory and the apparatus used without the alternator. Emergency lighting is provided by a 12-volt 180-ampere-hour accumulator charged either from the alternator or from the mains supply.

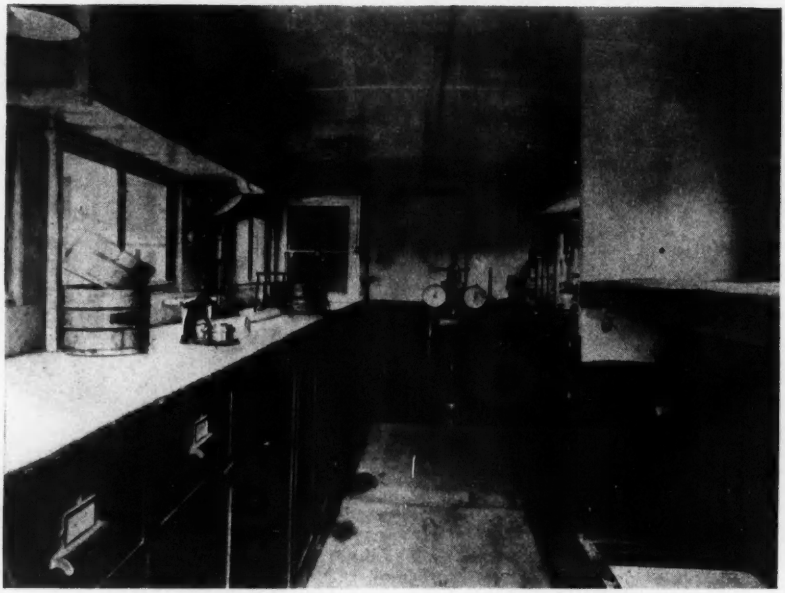


Fig. 2.—Interior of Mobile Testing Laboratory.

A supply of water is carried in a 30-gallon tank mounted above the main bench. Two sinks are fitted in the bench: one with a waste outlet leading directly out of the laboratory, the other with a waste outlet leading to a second tank beneath the bench from which the water can be returned to the supply tank by means of a semi-rotary hand pump. External fittings allow mains water to be used to fill the supply tank or to be connected direct to the internal system. Alternatively the pump can be used to fill the storage tank from external supplies.

Two sleeping bunks are provided. The upper bunk can be turned over and used as a bench or set to act as a back-rest when the lower bunk is used as a seat. A fume cupboard with an electric extractor fan is provided at one end of the main bench. A curing tank to hold 36 6-in. cubes is fitted beneath the lower bunk.

The main items of fitted equipment are as follows. (1) Hand-operated 100-ton hydraulic compression testing machine, having a second pressure gauge giving a range up to 25 tons—this machine (seen in *Fig.* 2) weighs about 9½ cwt. and was constructed especially for the laboratory; (2) standard mortar-cube vibrator made according to B.S. No. 12; (3) electric sieve-shaker; and (4) one 7-kg. and one 1-kg. semi-automatic balance. Other apparatus normally carried includes

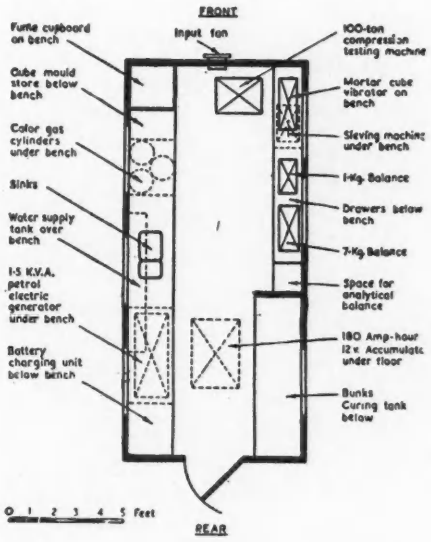


Fig. 3.

(1) cement-testing apparatus (according to B.S. No. 12); (2) a set of B.S. sieves from 1½ in. to No. 100; (3) cube moulds (3 in., 4 in., or 6 in. as required)—storage space for about 24 6-in. moulds is provided in lockers that open both inside and outside the laboratory (see *Fig.* 1); (4) slump apparatus; and (5) general apparatus such as bunsen burners, drying trays, trowels, scoops, floats, measuring jars, and thermometers.

The cost of the trailer and its equipment would be about £1,000 to £1,500.

The Cement Industry in Britain.

AT the annual general meeting of the Associated Portland Cement Manufacturers, Ltd., held in London last month, the chairman, Sir Malcolm Stewart, Bart., O.B.E., outlined the present position of the cement industry in this country. After referring to the need for postponing the annual meeting to a late date arising from the directors' decision that before completing the accounts for 1944 they should await the outcome of long-drawn out negotiations with the Ministry of Works fixing the quantum of profit from Portland cement trading to be allowed the industry, and stating that whilst discussions still continued regarding these profits the accounts had been closed on the basis of an estimate of the profits on Portland cement, he said that the proportions in which profits had been obtained from various sources of income had changed materially during the war years. The profits of the group, after charging depreciation, but before charging war damage insurance, taxation, and debenture services, were derived in the following manner : from Portland cement 38·5 per cent., from other trading activities 25·5 per cent., and from investment income and interest 36 per cent., which compared approximately with 66 per cent., 18 per cent., and 16 per cent. respectively in 1938 before taking into account a transfer to general reserve which was made in that year.

The modest increase of price of cement in the home market did not reasonably reflect the heavy additional costs of production. Whilst the net home trade selling price for the year 1944 was 34 per cent. above the same period of 1939, the relative increased cost of labour per ton of cement produced was 83 per cent. and that of electric power 87 per cent., while the price of coal at the works was up by no less than 94 per cent.

The high cost of building construction was rightly a cause for anxiety. The various contributing factors comprising the total cost needed analysis to get a true picture. It could be stated definitely that those materials least responsible for high costs were cement and bricks. The Minister of Health had stated in the House of Commons that cement was up in price over pre-war prices by 45 per cent. and bricks by 50 per cent. On the same occasion the Minister said that the value of the cement used for a house of 900 superficial feet was £29 at to-day's prices. This represented about 9 tons. His observations indicated that the amount was much less—usually about 3 tons, making, at to-day's prices, a cost of cement per house of between £9 and £10. The profit on these 3 tons of cement at the rate earned in 1939, and out of which debenture service, taxation and preference and ordinary dividends had to be paid, would not exceed 16s. The actual average net price per ton of cement at works received from the home trade consumer in 1944 was 34 per cent. over that received in 1939. The margin of profit per ton was less by 62 per cent. The industry's statement to the Minister of Works, when, early in the war, voluntary control of the industry was arranged, that the industry did not wish to profit by the war, hardly justified this drastic reduction. It was disconcerting to find that the industry's correct attitude was now being used to impose terms which did not in many cases leave a reasonable margin of profit on home trade cement deliveries, terms from which there

was no appeal but which were not, so far as he could ascertain, based on any principles which should fairly be deemed applicable to industry as a whole. Efficiency, enterprise, the taking of risks to expand, would not be encouraged by a process of beating down individual industries. In accordance with the spirit of democracy, the principle of what remuneration was to be permitted to industry should be settled on an orderly basis and be of general application, and not be dealt with in a capricious manner.

As soon as the necessary licences could be obtained and labour became available steps would be taken to catch up with repairs of and improvements to the works. Plans had also been prepared for increasing the capacity of some of the works and building new ones, but completion of these schemes was being held up owing to shortage of labour and of technical staff and delay in the delivery of machinery.

It was not possible with confidence to forecast improved results for the current year. The total deliveries were lower than in 1944, but the proportion exported showed improvement and, further, home trade deliveries were being more economically distributed. These factors should prove helpful. The return to full output and efficiency of the works was being greatly retarded by the slow release of men from the Forces. They had even had to refuse export orders recently on account of lack of the necessary labour for handling these orders at their exporting works. However, they looked for increased deliveries in 1946 and an improvement in that year of trading results, although it must be realised it would take some time before the building and constructional industries could get into their full stride.

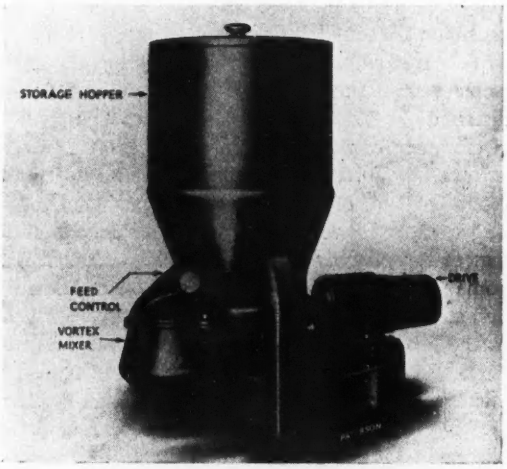
[At meetings of the boards of The Associated Portland Cement Manufacturers, Ltd., and The British Portland Cement Manufacturers, Ltd., held on December 20, 1945, Sir P. Malcolm Stewart, Bt., placed his resignation as Chairman of both companies in the hands of the boards with effect on December 31, 1945. At the same time he also resigned his managing directorships. These resignations have been accepted with regret. Sir Malcolm, however, has been appointed, from January 1, 1946, Advisory Director in a consultative capacity to the boards and the Managing Directors, and designated President of both companies. The respective boards have appointed Mr. G. F. Earle, who has been a Managing Director of both companies since 1937, as Chairman to succeed Sir Malcolm. Mr. Earle is also Chairman of The Cement Marketing Co., Ltd., and of Messrs. G. & T. Earle, Ltd.]

General Refractories, Ltd.

Dr. H. M. Glass, M.Sc., Ph.D., F.R.I.C., has been appointed director of research of General Refractories, Ltd., of Sheffield. Dr. Glass was formerly with I.C.I., Ltd., of Billingham, where he was in charge of the Non-Metallic Materials Section and was engaged in research on refractories, chemical stoneware, chemically-resistant cements and concretes, and other materials used in the construction of chemical plant.

Continuous Feeder for Granular Material.

THE illustration shows a machine designed for the continuous feeding at any desired speed, which may be varied by the rotation of a knob, of a wide range of granular materials. Essentially the machine consists of a sheet-metal cylindrical storage hopper with cover, an electric motor, and a vortex mixer delivering the material (after mixing with water if desired) from a pipe at the bottom, and a feed-control mechanism to vary the amount of feed from the hopper mixer. The machine is made in two sizes with overall heights of 3 ft. 6 in. and 4 ft. respectively. The machine can be fitted with an additional storage hopper for feeding into the machine hopper.



Continuous Feeder.

The hopper capacities are 2½ and 5 cu. ft. respectively, and the motors are ¼ h.p. and ½ h.p. In the case of hydrated lime the smaller feeder will deliver from 0·15 lb. to 150 lb. per hour. With heavier material the delivery is up to approximately 1,000 lb. per hour. Thus for chalk the capacity of the small machine is 0·28 lb. to 280 lb. per hour; of the larger machine, 0·9 lb. to 900 lb. per hour. At the bottom of the stationary hopper is a slowly rotating feed table, and projecting into the bottom of the hopper is an adjustable sectional feed knife which deflects a constant flow of material into the mixer. The position of the feed knife, which is adjusted by the control knob, determines the amount of material discharged to the mixer, and this may be altered while the machine is running. For materials that have a tendency to arch or pack, the hopper is provided with a moving agitator. The machine is supplied by the Paterson Engineering Co., Ltd.